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(54) **STARTING DEVICE FOR AN INTERNAL COMBUSTION ENGINE**

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CPC .. ***F02N 5/02*** (2013.01); ***F02N 3/02*** (2013.01); *F02N 15/063* (2013.01); *F02N 15/065* (2013.01)

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See application file for complete search history.

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(57) **ABSTRACT**

A starting device for an internal combustion engine includes a pulley mounted rotatably in a housing which can be set in rotation by a tension means to produce a drive torque for a motor shaft by a starter handle and which is connected to an engaging member by a damping spring. The drive torque is transmitted to the motor shaft to start the internal combustion engine, whereby under torsion of the damping spring, a twisting of the pulley against the engaging member is rendered possible until a stop element impacts against a counter-stop to delimit the twisting, which enables a high operational readiness of the starting device. In the case of a defect of the damping spring, the stop element and/or the counter-stop is formed from a material which has a higher strength than the material of the engaging member and/or the material of the pulley.

10 Claims, 6 Drawing Sheets

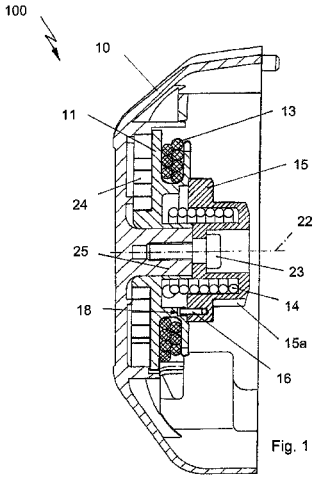

Fig. 1

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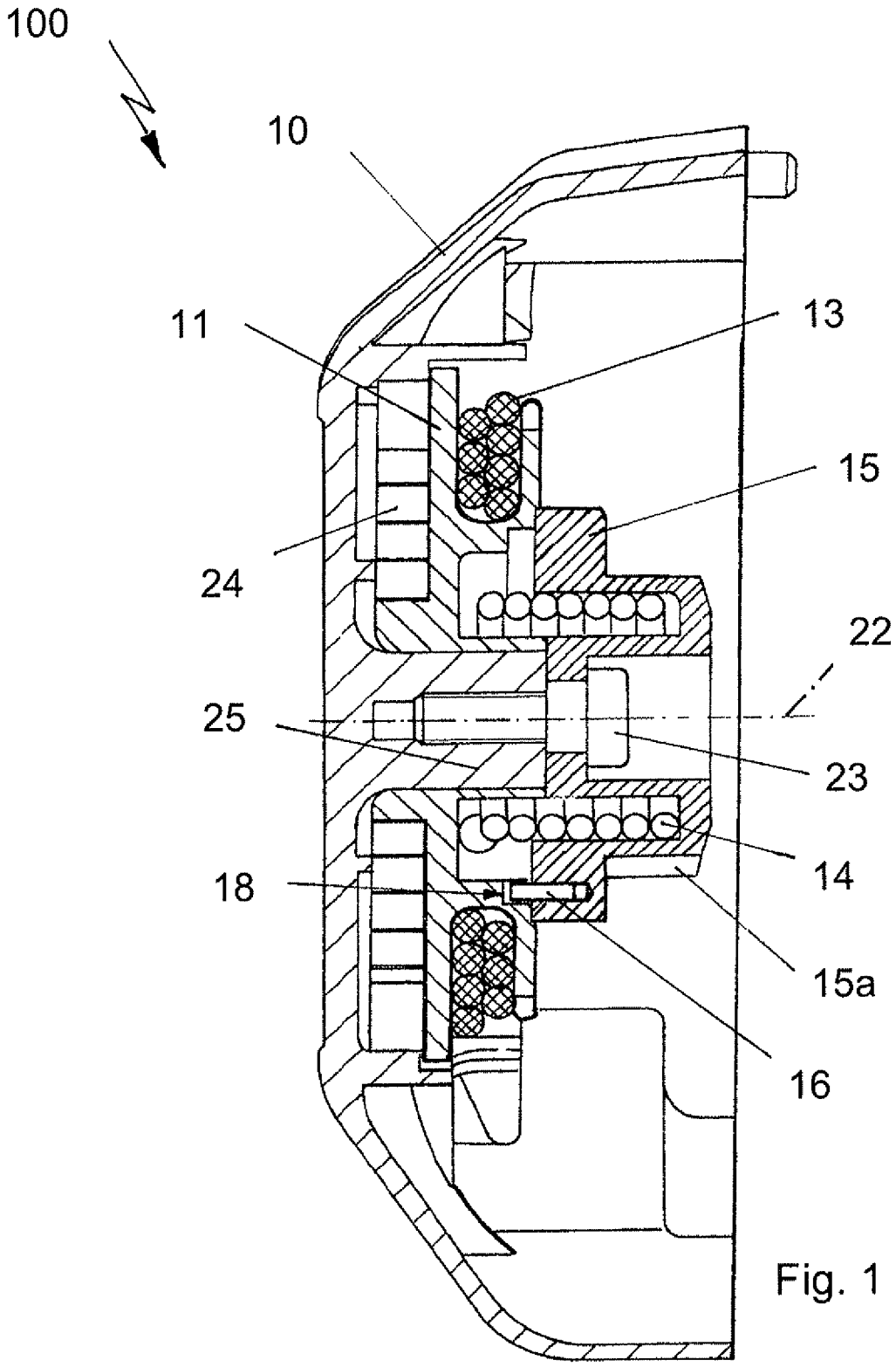

Fig. 1

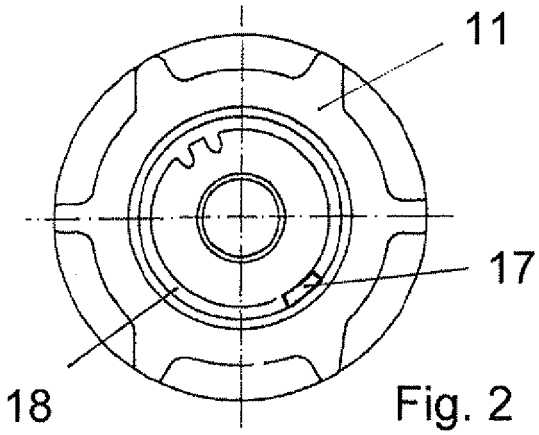

Fig. 2

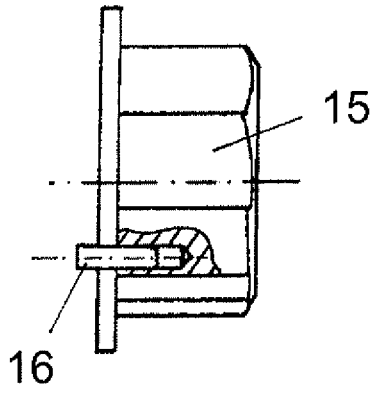

Fig. 3

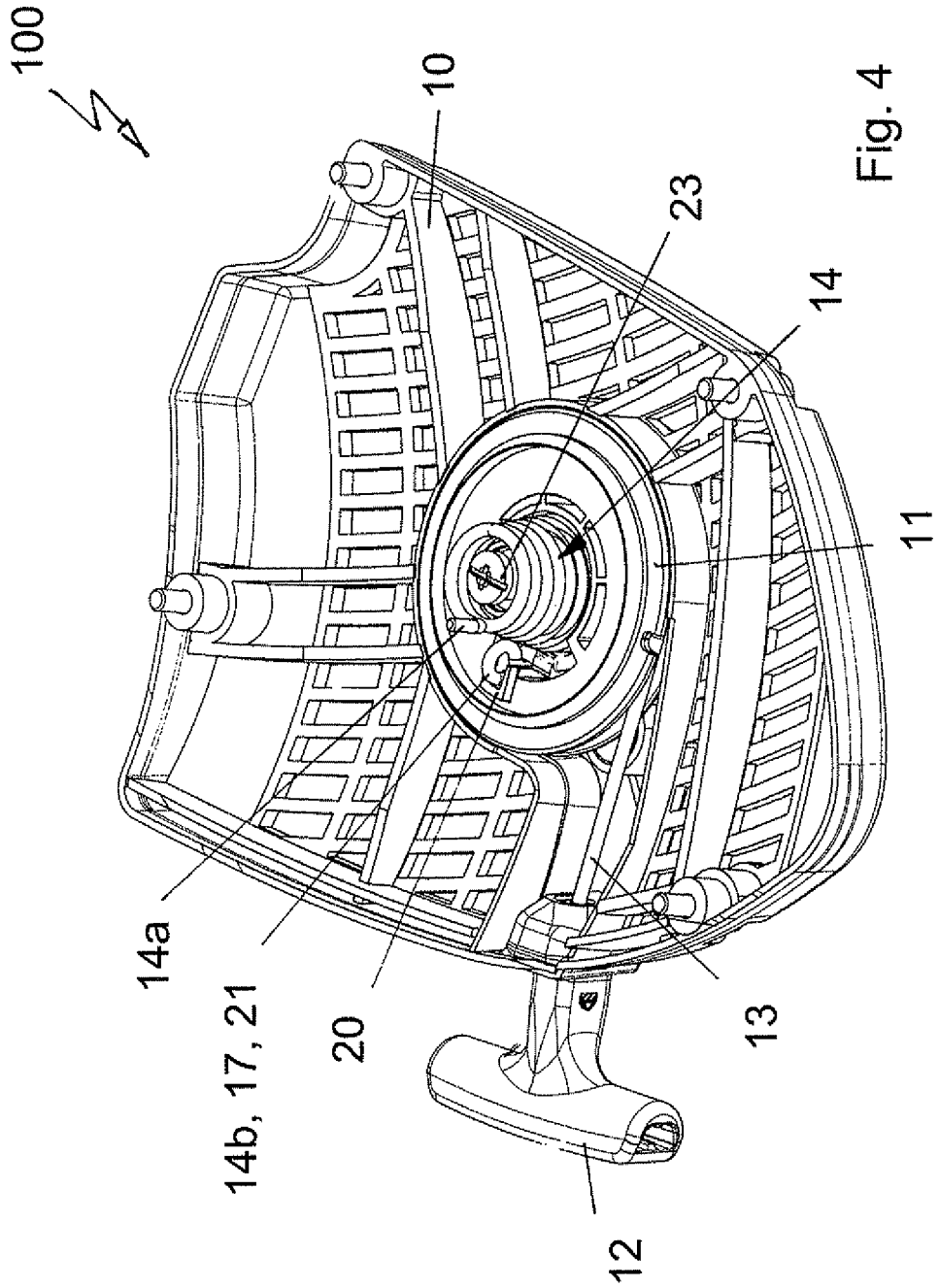

Fig. 4

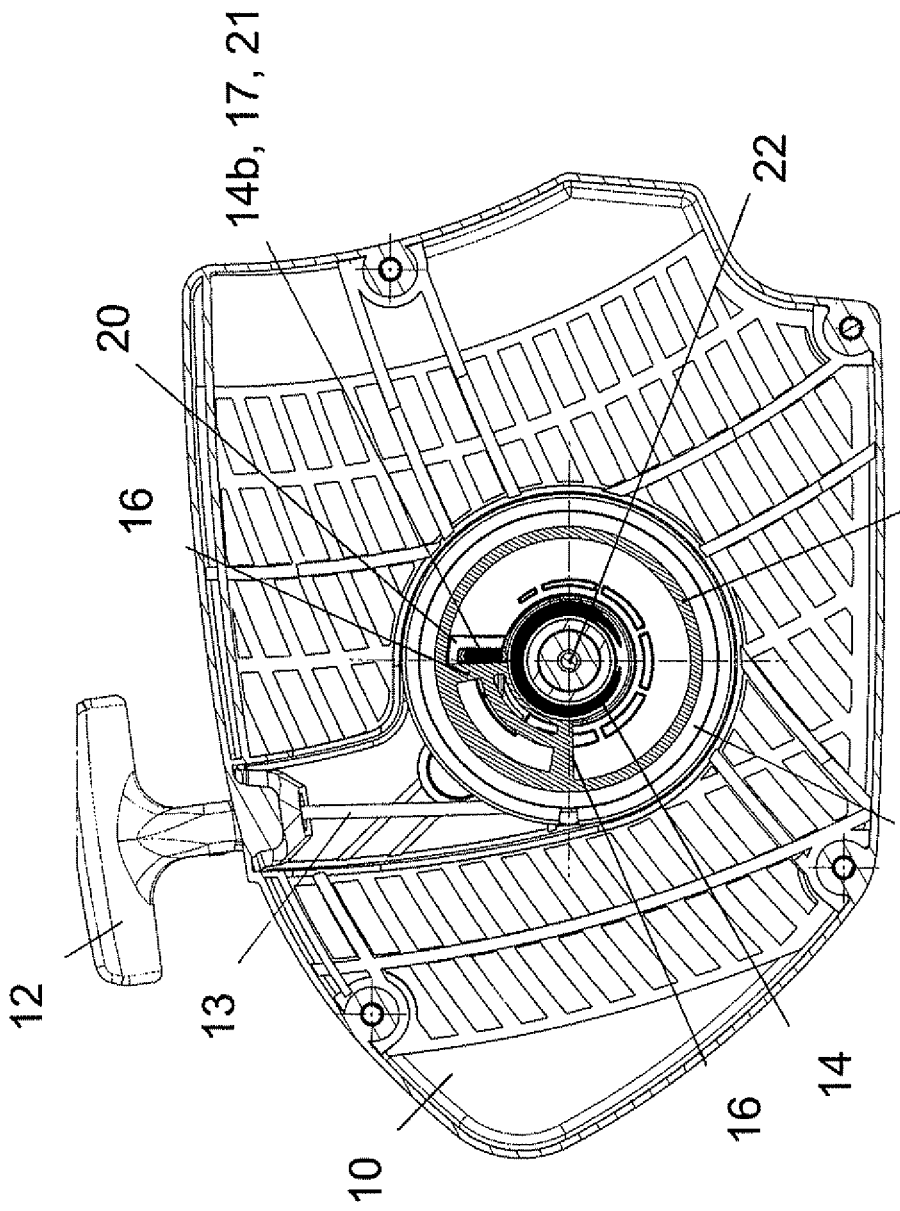

Fig. 5

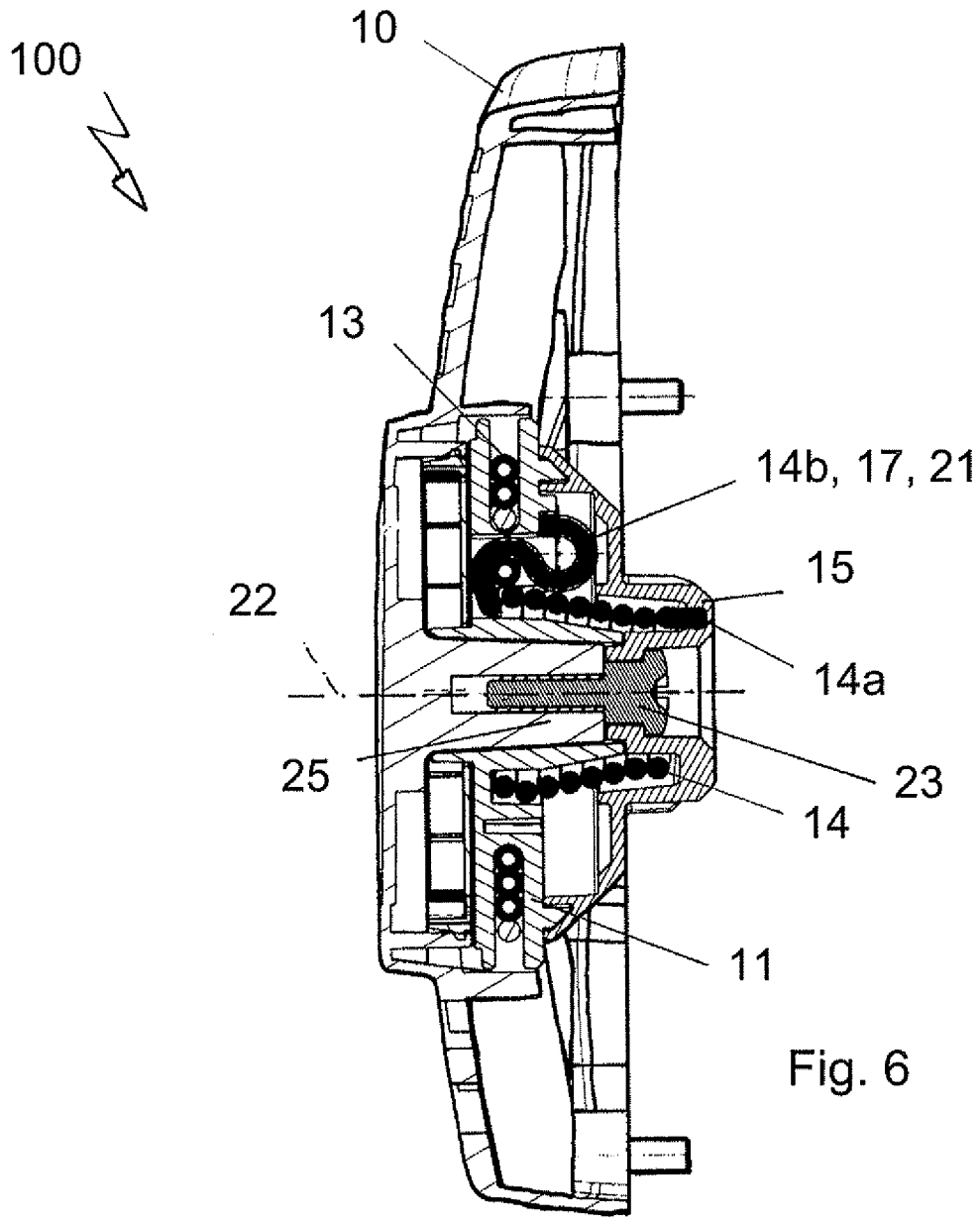

Fig. 6

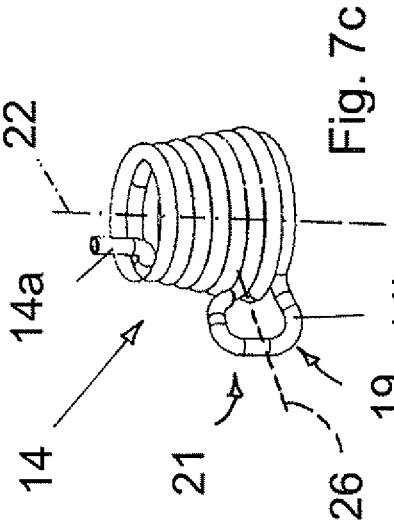

Fig. 7c

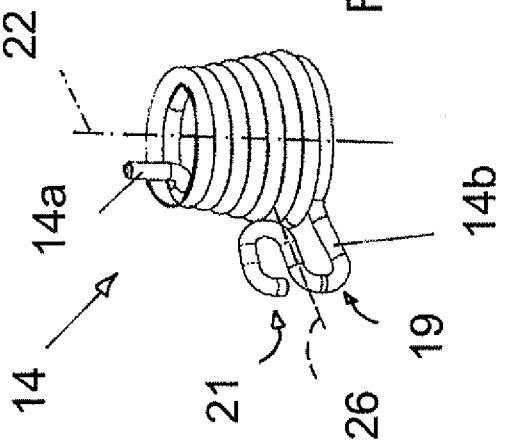

Fig. 7b

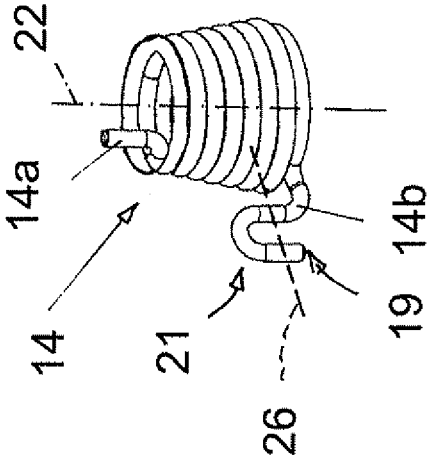

Fig. 7a

STARTING DEVICE FOR AN INTERNAL COMBUSTION ENGINE

The present invention is directed towards a starting device for an internal combustion engine comprising a pulley mounted rotatably in a housing which can be set in rotational movement by means of a tension means to produce a drive torque for a motor shaft by means of at least one starter handle and which is connected to an engaging member by means of a damping spring formed from a spring wire, by which means the drive torque can be transmitted to the motor shaft to start the internal combustion engine, whereby under torsion of the damping spring, a twisting of the pulley against the engaging member is rendered possible until a stop element impacts against a counter-stop to delimit the twisting.

PRIOR ART

Document DE 203 01 182 U1 discloses a generic starting device for an internal combustion engine and a starter handle is connected to a tension means that is rolled on a pulley. If the user pulls on the starter handle, the pulley is set in rotation by means of the tension means and the rotation is transmitted by means of a damping spring to an engaging member by which means the drive torque can be transmitted to the motor shaft to start the internal combustion engine.

When a user pulls the starter handle and thereby sets the pulley in rotation, the angle of rotation of the pulley can already differ from the angle of rotation of the engaging member. If an internal combustion engine is being started by starting to turn the motor shaft by applying a torque, a non-uniform torque profile is obtained during rotation of the motor shaft due to the reciprocating piston principle of the internal combustion engine. In the compression phase a piston guided in the cylinder increases the torque and consequently acts against the drive torque. In the decompression phase on the other hand, a rotational movement of the motor shaft is supported and when the motor shaft begins to rotate, a periodic force profile having corresponding force peaks is consequently obtained. This therefore means that the torque to be applied to the motor shaft is subject to strong fluctuations which can be transmitted to the pulley and therefore also to the starter handle. In order to avoid or at least reduce the transmission of the force peaks from the engaging member that, when starting the internal combustion engine, is connected to the motor shaft, to the pulley, the damping spring is provided which allows a torsion between the pulley and the engaging member in order to be able to twist the engaging member towards the pulley at least in a predefined angular range. Consequently, the force peaks are only transmitted to the pulley to a reduced extent.

In order to limit the twisting of the engaging member with respect to the pulley and in order to thereby avoid damage to the damping spring due to overstressing, a stop element is provided which can come to abut against a counter-stop, whereby the maximum angle of twist of the engaging member with respect to the pulley is limited, so that the maximum torsion of the damping spring is also limited.

In the event of a break of the damping spring but also in the case of an elastic overstressing of the damping spring, an appreciable force can act on the stop of the stop element against the counter-stop due to the force peaks of the internal combustion engine. This can have the result that the stop element or the counter-stop element fails mechanically, in particular a rupture of the stop element or the counter-stop element can occur.

In order to increase the loading capacity of the stop, two stop elements can be provided which are disposed diametrically opposite to one another on the engaging member. Consequently, two stops can come to abut against a respective counter-stop in order to allow the maximum load-bearing capacity for transmission of a torque from the pulley to the engaging member if, for example, the damping spring is broken. Disadvantageously, however the maximum angle of twist is thereby halved since the stops are offset by a maximum of 180° with respect to one another.

If a rupture of the damping spring occurs, it is desirable to be able to further operate the starting device at least temporarily despite the broken damping spring. Such emergency operation of the starting device in the event of a defect of the damping spring can take place by transmitting a torque from the pulley to the engaging member directly via the stop element and the counter-stop element. If the stop element comes to abut against the counter-stop, a torque can be transmitted in this way from the pulley to the engaging member without however suppressing the force peaks from the internal combustion engine on the pulley. If, however, the internal combustion engine is started with a defective damping spring, the force peaks can cause a mechanical rupture of the stop element and/or the counter-stop and it is desirable to avoid this.

It is therefore the object of the present invention to provide a starting device for an internal combustion engine which allows a high operational readiness of the starting device, in particular in the case of a defect of the damping spring.

This object is solved starting from a starting device for an internal combustion engine according to the preamble of claim **1** in conjunction with the characterising features. Advantageous further developments of the invention are specified in the dependent claims.

DISCLOSURE OF THE INVENTION

The invention includes the technical teaching that the stop element and/or the counter-stop are formed from a material that has a higher strength than the material of the engaging member and/or than the material of the pulley.

The invention starts from the idea of forming the stop element and/or the counter-stop from a material that differs from the material of the engaging member and/or the material of the pulley. It is particularly advantageous to make the engaging member and/or the pulley from a plastic material, in particular in an injection moulding process. The plastic materials to be processed thereby have merely a low strength so that the problem described hereinbefore can arise that the stop element and/or the counter-stop undergo a mechanical rupture when, in the case of a defect in the damping spring, the force peaks upon starting the internal combustion engine are transmitted directly from the engaging member into the pulley. With the choice of materials according to the invention, the engaging member and/or the pulley can still be made of a favourable plastic material from the production technology viewpoint, where the stop element and/or the counter-stop can be formed from a different material, in particular from a higher-strength material so that failure of the stop element and/or the counter-stop does not experience any damage even when force peaks occur.

According to an advantageous embodiment, the stop element can be formed from a metal material, in particular from a steel material, where in particular the engaging member and/or the pulley are formed from a plastic material. Likewise, the counter-stop can be configured as an insert element made of a high-strength material, in particular as an insert element made of a metal material and be inserted in the pulley.

Preferably both the stop element for the engaging member and also the counter-stop for the pulley are over-moulded in a plastic injection moulding process so that the stop element and/or also the counter-stop are already inserted in an injection mould when the plastic material is injected into the mould.

According to one possible embodiment, the stop element can be disposed on the engaging member and project from a surface of the engaging member facing the pulley, in particular the stop element can be configured as a pin element or as a bolt element and extend from the surface of the engaging member facing the pulley in the direction of the pulley. A guide groove can be incorporated in the pulley, in which the stop element is guided, where the counter-stop engages in the guide groove. The maximum twisting of the engaging member with respect to the pulley can be limited by the stop element impacting against the counter-stop. Alternatively it is also possible to provide the stop element in the same way in the pulley and the guide groove can be incorporated in the engaging member.

Advantageously, the spring wire of the damping spring can have two ends and a first end can be in engagement with the engaging member and a second end can be in engagement with the pulley, where the counter-stop is formed from the spring wire of the damping spring, which in particular comprises a high-hardness metal material. According to the invention, the damping spring on the one hand fulfils the damping function between the pulley and the engaging member, on the other hand the damping spring forms the counter-stop against which the stop element can impact to limit the twisting of the engaging member with respect to the pulley.

In particular, the counter-stop can be formed from the second end of the spring wire of the damping spring that is in engagement with the pulley. The second end of the spring wire of the damping spring can have a curved shape, where the curved shape is encased with a first segment in a receptacle of the pulley for engagement therein and projects with a second segment from the receptacle of the pulley in the direction of the engaging member. The part of the second end which is encased in the receptacle of the pulley on the one hand fixes the damping spring in the pulley so that a torque can be applied from the pulley onto the damping spring and furthermore, the first segment of the second end which is encased in the receptacle fulfils a fixing of the second end so that the second segment projecting from the receptacle is rigidly connected to the pulley in order to form the counter-stop.

The curved shape of the second end of the spring wire of the damping spring can have an S shape, a C shape or an inverted U shape. At the same time, the second end of the spring wire of the damping spring can extend with its curved shape in one plane, in particular the S shape, the C shape or the inverted U shape can extend in one plane, where the damping spring has a central axis which lies in the plane of the second end. The plane is thus defined by the central axis and an axis running orthogonally to the central axis, and the second end of the spring wire extends approximately perpendicularly from the body of the damping spring. The second end of the spring wire can have any curved shape and the S shape, the C shape or the inverted U shape each form only one possible advantageous embodiment in order on the one hand to form the first segment which can be inserted in the receptacle of the pulley and in order on the other hand to form the second segment which serves as a counter-stop for the stop element. The inverted U shape thereby describes a "U" and the open side of the "U" is inserted in the receptacle so that only one loop of the spring wire projects from the receptacle as the second segment in order to form a rigid, loadable counter-stop.

In order to form the stop element and/or the counter-stop from a material that has a higher strength than the material of the engaging member and/or than the material of the pulley, the stop element and/or the counter-stop can merely be reinforced by a higher-strength material, for example, by a metal material. For example, the stop element and/or the counter-stop can be formed in one piece and of the same material using the material of the engaging member and/or using the material of the pulley and the stop element and/or the counter-stop is merely reinforced with a higher-strength material, for example, by a metal core or by a metal attachment.

BRIEF DESCRIPTION OF THE DRAWINGS

Further measures which improve the invention are presented in detail hereinafter jointly with the description of a preferred exemplary embodiment of the invention by reference to the figures. In the figures:

FIG. **1** shows an exemplary embodiment of a starting device in a cutaway view with the features of the present invention,

FIG. **2** shows a view of a pulley with a counter-stop,

FIG. **3** shows a side view of an engaging member in which a stop element is incorporated,

FIG. **4** shows a perspective view of the starting device according to another exemplary embodiment,

FIG. **5** shows a perspective view of the starting device according to the exemplary embodiment in FIG. **4**,

FIG. **6** shows a transverse cutaway side view of an exemplary embodiment of the starting device according to the exemplary embodiment from FIG. **4** and FIG. **5**,

FIG. **7***a* shows a perspective view of a damping spring according to a first exemplary embodiment,

FIG. **7***b* shows a perspective view of a damping spring according to a second exemplary embodiment and

FIG. **7***c* shows a perspective view of a damping spring according to a third exemplary embodiment.

PREFERRED EXEMPLARY EMBODIMENTS OF THE INVENTION

FIG. **1** shows an exemplary embodiment of a starting device **100** for an internal combustion engine having a pulley **11** mounted rotatably in a housing **10**. A tension means **13** which is executed in the form of a cable is wound on the pulley **11**. The pulley is mounted rotatably in the housing **10** and when one end of the tension means **13** is pulled manually, the pulley **11** is set in rotational movement. The pulley **11** is mounted rotatably about a central axis **22**, where a damping spring **14** is shown, this spring being firmly connected with an end pointing towards the pulley **11** to said pulley in a manner not shown in detail. Located on the side of the damping spring **14** opposite the pulley **11** is an engaging member **15** and the end of the damping spring **14** pointing in the direction of the engaging member **15** is connected in a torque-resistant manner to the engaging member **15**. Consequently, the damping spring **14** forms a torsion element that connects the pulley **11** to the engaging member **15** in a torsionally elastic manner. Due to the torsional elasticity of the damping spring **14**, a relative movement can therefore take place between the pulley **11** and the engaging member **15**.

If the pulley **11** is set in rotational movement by pulling on the tension means **13**, the damping spring **14** also co-rotates about the central axis **22**. The engaging member **15** is thereby also set in rotational movement, which member can engage

via an engaging contour **15***a* in detent elements not shown in detail, by which means the motor shaft of the internal combustion engine can be turned. The pulley **11**, the damping spring **14** and the engaging member **15** are accommodated rotatably via a central screw **23** on a bearing mandrel **25** which is formed as part of the housing **10**. A return spring **24** serves to turn the pulley **11** back again opposite to the direction of rotation when the tension means **13** is released again. When pulling on the tension means **13**, the pulley **11** is turned in the direction of rotation of the motor shaft whilst the tension means **13** is unwound from the pulley **11**. The return spring **24** is then used to drive the pulley **11** to rotate in the opposite direction again, so that the tension means **13** can be wound on again.

A stop element **16** is inserted in the engaging member **15** which is designed, for example, as a bolt element and is disposed in a hole incorporated in the engaging member **15**. The bolt-like stop element **16** is made of a steel material and projects a little distance from the surface of the engaging member **15** pointing in the direction of the pulley **11**. Corresponding to the arrangement of the stop element **16**, a guide groove **18** is introduced in the pulley **11** and when a relative rotation of the engaging member **15** takes place under simultaneous torsion of the damping spring **14** with respect to the pulley **11**, the stop element **16** runs in the guide groove **18** until the stop element **16** comes to abut against a counter-stop not shown in detail.

FIG. **2** shows a view of the pulley **11** from the direction in which the pulley **11** points towards the engaging member **15**. The guide groove **18** is shown in the surface of the pulley **11** shown and a counter-stop **17** is incorporated in the course of the guide groove **18**. The counter-stop **17** is shown, for example, as a metal insert element and the pulley **11** is made of a plastic material so that the counter-stop **17** according to the invention comprises a higher-strength material than the pulley **11**.

FIG. **3** shows a side view of the engaging member **15** in which a stop element **16** is inserted, this being designed as a bolt element and consisting of a steel material. The engaging member **15** on the other hand is made of a plastic material so that the stop element **16** according to the invention comprises a higher-strength material than the engaging member **15**.

FIG. **4** shows another exemplary embodiment of a starting device **100** with a housing **10** which rotatably accommodates a pulley **11**. A damping spring **14** is also shown where, for the perspective view of the pulley **11** and the arrangement of the damping spring **14**, the engaging member **15** is removed, with the central screw **23** being shown, which indicates the axis of rotation of the pulley **11** and the damping spring **14**. A starter handle **12** is also shown, which is disposed at the end on the tension means **13**. If a tensile force is introduced manually via the starter handle **12** into the tension means **13**, the pulley **11** is brought into rotation about the central screw **23**.

The damping spring **14** has a first end **14***a* by which means the damping spring **14** is connected to the engaging member **15** not shown in detail. The damping spring **14** further comprises a second end **14***b* which is rigidly disposed in the pulley **11**.

For the rigid arrangement of the second end **14***b* of the damping spring **14** in the pulley **11**, this has a receptacle **20** and the second end **14***b* of the damping spring **14** is inserted with a first segment in the receptacle **20**. A second segment **21** of the second end **14***b* of the damping spring **14** projects from the receptacle **20** and forms the counter-stop **17** against which a stop element **16** of the engaging member **15** is brought to abut when the angle of twist of the pulley **11** with respect to the engaging member **15** reaches a maximum. The second segment **21** of the second end **14***b* of the damping spring **14** projects from the receptacle **20** in a loop-like manner and the damping spring **14** is made of a high-strength metal material and the material of the damping spring **14** is harder than the material of the pulley **11** which is preferably made of plastic.

FIG. **5** shows the engaging member **15** in a cutaway view and this has a first stop surface for forming the stop element **16** and the second segment **21** of the second end **14***b* of the damping spring **14** which projects from the receptacle **20** of the pulley **11** abuts against the first stop surface of the stop element **16**. If a tensile force is introduced into the tension means **13** via the starter handle **12**, and if the pulley **11** is set in rotation clockwise about the central axis **22**, the pulley **11** can twist so far against the engaging member **15** that the counter-stop **17** formed by the second segment **21** of the second end **14***b* of the damping spring **14** comes to abut against the second stop surface of the stop element **16**. The pulley **11** thereby twists through 270° with respect to the engaging member **15**.

FIG. **6** shows a transverse cutaway side view of the starting device according to the exemplary embodiment from FIGS. **4** and **5**. The housing is shown in a cutaway view and the pulley **11** with the tension means **13**, the damping spring **14** and the engaging member **15** are fastened rotatably about the central axis **22** by means of the central spring **23** on the bearing mandrel **25** of the housing **10**. In the transverse cutaway view of the damping spring **14**, the first end **14***a* and the second end **14***b* of the damping spring **14** can be identified. The first end **14***a* is firmly connected to the engaging member **15**, where the second end **14** has an S shape and a second segment **21** projects from the pulley **11** in order to form the counter-stop **17**. A stop element of the engaging member **15** can come to abut against the counter-stop **17** when the engaging member **15** reaches the maximum angle of twist relative to the pulley **11**.

FIGS. **7***a*, **7***b* and **7***c* each show respective exemplary embodiments of the damping spring **14** which extend about the central axis **22**. The damping springs **14** are designed as helical springs and have a conical shape. The end of the conical shape of the damping spring **14** having the smaller diameter forms the first end **14***a* which is connected to the engaging member **15**. The second end **14***b* is formed on the larger diameter of the conical shape and extends in a plane away from the damping spring **14** and the plane is defined by the central axis **22** and the direction of extension **26** of the second end **14***b* of the damping spring **14**.

FIG. **7***a* shows a damping spring **14** with a second end **14***b* which is configured in the form of an inverted "U". The direction of extension **26** is shown at a height which separates the first segment **19** of the curved form of the second end **14***b* from the second segment **21**. The first segment **19** is used for insertion in the receptacle **20** in the pulley **11** and the second segment **21** projects from the receptacle **20** of the pulley **11** in order to form the counter-stop **17**.

FIG. **7***b* shows an S shape of the second end **14***b* where the direction of extension **26** is shown at half S height. Consequently the lower first segment **19** of the S shape can be inserted in the receptacle **20** and the upper second segment **21** projects from the receptacle **20**.

FIG. **7***c* shows a C shape of the second end **14***b* of the damping spring **1** and the lower first segment **19** can again be inserted into the receptacle **20** whilst the upper second segment **21** projects from the receptacle **20** in order to form the counter-stop **17**.

The invention is not restricted in its execution to the preferred exemplary embodiment specified hereinbefore. On the contrary, a number of variants are feasible which make use of

the solution presented in fundamentally different embodiments. All the features and/or advantages deduced from the claims, the description or the drawings, including constructive details or spatial arrangements, can be essential for the invention both for themselves and in various combinations.

REFERENCE LIST

100 Motor-driven implement
10 Housing
11 Pulley
12 Starter handle
13 Tension means
14 Damping spring
14*a* First end
14*b* Second end
15 Engaging member
15*a* Engaging contour
16 Stop element
17 Counter-stop
18 Guide groove
19 First part of curved shape
20 Receptacle
21 Second part of curved shape
22 Central axis
23 Central screw
24 Return spring
25 Bearing mandrel
26 Direction of extension

The invention claimed is:

1. A starting device for an internal combustion engine comprising:

a pulley mounted rotatably in a housing;

a tensioning member configured to rotate the pulley in response to a force introduced via a starter handle, the pulley being configured to produce a drive torque for a motor shaft;

an engaging member coupled with the pulley by a damping spring formed from a spring wire, the damping spring being configured to transmit the drive torque to the motor shaft to start the internal combustion engine;

a stop element arranged on the engaging member; and

a counter-stop arranged on the pulley, wherein

under torsion of the damping spring, the pulley is rotatable relative to the engaging member until the stop element impacts against the counter-stop,

the stop element and/or the counter-stop is formed from a material which has a higher strength than a material of the engaging member and/or a material of the pulley, and

the stop element is made of a metal material, and the engaging member and/or the pulley is formed from a plastic material,

the counter-stop is configured as an insert element made of a high-strength material, and is inserted in the pulley, and

the counter-stop is statically coupled relative to the pulley.

2. The starting device according to claim **1**, wherein the stop element is disposed on the engaging member and projects from a surface of the engaging member facing the pulley, wherein the stop element is configured as a pin or bolt and extends from the surface of the engaging member facing the pulley in a direction of the pulley.

3. The starting device according to claim **1**, wherein the pulley includes a guide groove in which the stop element is guided, and

the counter-stop engages the stop element in the guide groove.

4. The starting device according to claim **1**, wherein

the spring wire of the damping spring has two ends,

a first end of the spring wire is in engagement with the engaging member, and a second end of the spring wire is in engagement with the pulley, and

the counter-stop is formed from the spring wire of the damping spring, which comprises a high-hardness metal material.

5. The starting device according to claim **4**, wherein the counter-stop is formed from the second end of the spring wire of the damping spring that is in engagement with the pulley.

6. The starting device according to claim **4**, wherein the second end of the spring wire of the damping spring has a curved shape, wherein a first segment of the curved shape is encased in a receptacle of the pulley for engagement therein, and a second segment of the curved shape projects from the receptacle of the pulley in a direction of the engaging member.

7. The starting device according to claim **6**, wherein the curved shape of the second end of the spring wire of the damping spring has a S shape, or a C shape, or an inverted U shape.

8. The starting device according to claim **6**, wherein the second end of the spring wire of the damping spring extends with the curved shape in one plane, wherein the damping spring has a central axis which lies in the one plane of the second end.

9. The starting device according to claim **1**, wherein the counter-stop is made of a metal material, and the engaging member and the pulley are formed from a plastic material.

10. The starting device according to claim **1**, wherein the engaging member is formed from a plastic material.

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